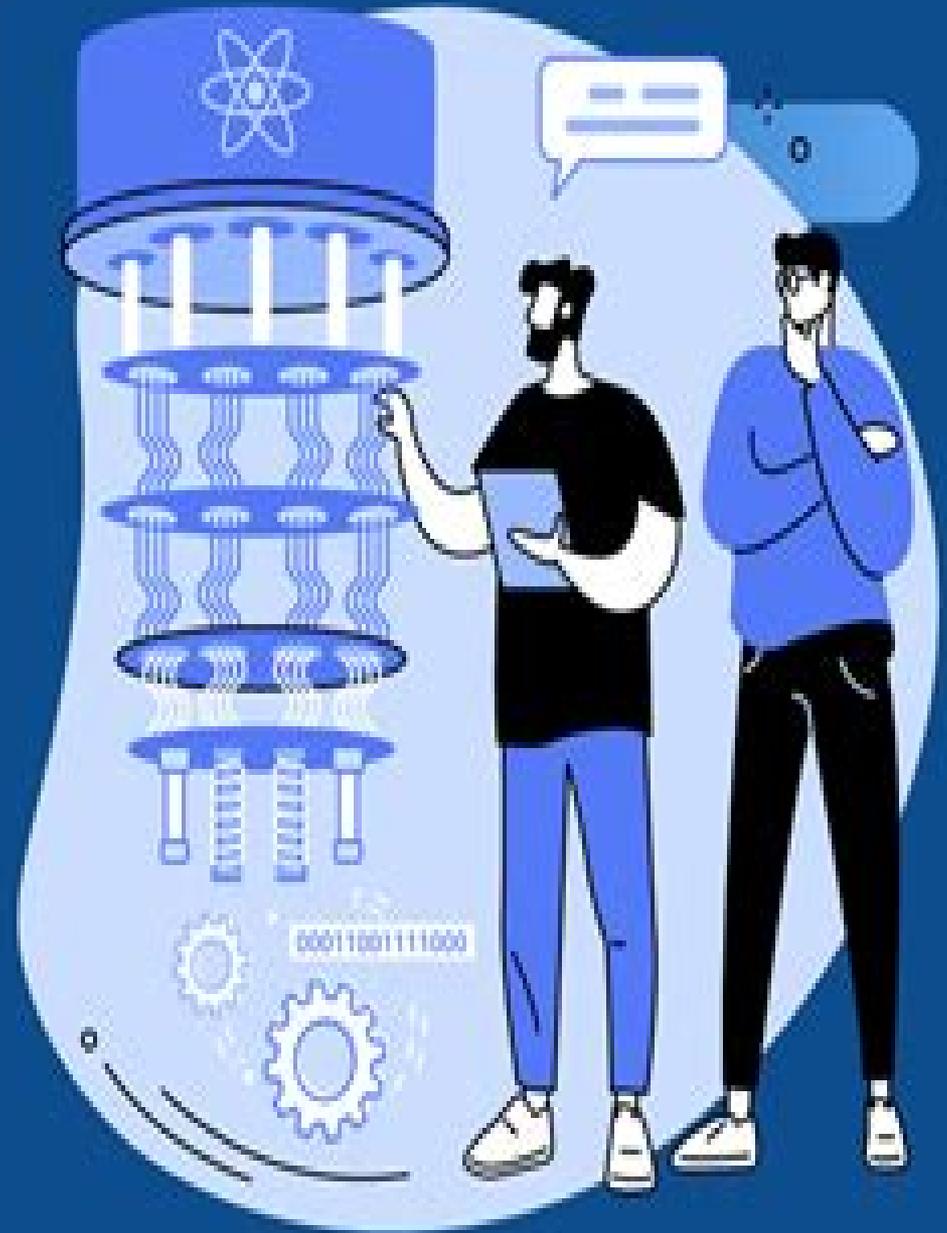


# Quantum Computing Algorithms



# An Introduction To Quantum Computing Algorithms

**Johannes A. Buchmann**



## **An Introduction To Quantum Computing Algorithms:**

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linear algebra is assumed including vector spaces and inner products However prior familiarity with topics such as quantum mechanics and computational complexity is not required [Introduction to Quantum Algorithms via Linear Algebra, second edition](#) Richard J. Lipton, Kenneth W. Regan, 2021-04-06 Quantum computing explained in terms of elementary linear algebra emphasizing computation and algorithms and requiring no background in physics This introduction to quantum algorithms is concise but comprehensive covering many key algorithms It is mathematically rigorous but requires minimal background and assumes no knowledge of quantum theory or quantum mechanics The book explains quantum computation in terms of elementary linear algebra it assumes the reader will have some familiarity with vectors matrices and their basic properties but offers a review of the relevant material from linear algebra By emphasizing computation and algorithms rather than physics it makes quantum algorithms accessible to students and researchers in computer science who have not taken courses in quantum physics or delved into fine details of quantum effects apparatus circuits or theory [Introduction to Quantum Algorithms](#) Johannes A. Buchmann, 2024-03-18 Quantum algorithms are among the most important interesting and promising innovations in information and communication technology They pose a major threat to today's cybersecurity and at the same time promise great benefits by potentially solving previously intractable computational problems with reasonable effort The theory of quantum algorithms is based on advanced concepts from computer science mathematics and physics [Introduction to Quantum Algorithms](#) offers a mathematically precise exploration of these concepts accessible to those with a basic mathematical university education while also catering to more experienced readers This comprehensive book is suitable for self study or as a textbook for one or two semester introductory courses on quantum computing algorithms Instructors can tailor their approach to emphasize theoretical understanding and proofs or practical applications of quantum algorithms depending on the course's goals and timeframe [Introduction To Quantum Computers](#) Gennady P Berman, Gary D Doolen, Ronnie Mainieri, Vladimir I Tsifrinovich, 1998-07-07 Quantum computing promises to solve problems which are intractable on digital computers Highly parallel quantum algorithms can decrease the computational time for some problems by many orders of magnitude This important book explains how quantum computers can do these amazing things Several algorithms are illustrated the discrete Fourier transform Shor's algorithm for prime factorization algorithms for quantum logic gates physical implementations of quantum logic gates in ion traps and in spin chains the simplest schemes for quantum error correction correction of errors caused by imperfect resonant pulses correction of errors caused by the nonresonant actions of a pulse and numerical simulations of dynamical behavior of the quantum Control Not gate An overview of some basic elements of computer science is presented including the Turing machine Boolean algebra and logic gates The required quantum ideas are explained [Quantum Computing](#) Eleanor G. Rieffel, Wolfgang H. Polak, 2014-08-29 A thorough exposition of quantum computing and the underlying concepts of quantum physics with explanations of the relevant mathematics and numerous examples The combination of two of the twentieth century's most influential and revolutionary

scientific theories information theory and quantum mechanics gave rise to a radically new view of computing and information Quantum information processing explores the implications of using quantum mechanics instead of classical mechanics to model information and its processing Quantum computing is not about changing the physical substrate on which computation is done from classical to quantum but about changing the notion of computation itself at the most basic level The fundamental unit of computation is no longer the bit but the quantum bit or qubit This comprehensive introduction to the field offers a thorough exposition of quantum computing and the underlying concepts of quantum physics explaining all the relevant mathematics and offering numerous examples With its careful development of concepts and thorough explanations the book makes quantum computing accessible to students and professionals in mathematics computer science and engineering A reader with no prior knowledge of quantum physics but with sufficient knowledge of linear algebra will be able to gain a fluent understanding by working through the book

**An Introduction to Quantum Computing** Phillip Kaye, Raymond Laflamme, Michele Mosca, 2007 The authors provide an introduction to quantum computing Aimed at advanced undergraduate and beginning graduate students in these disciplines this text is illustrated with diagrams and exercises

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basic unit of computation is the qubit not the bit      **Concise Guide to Quantum Computing** Sergei Kurgalin,Sergei Borzunov,2021-02-24 This textbook is intended for practical laboratory sessions associated with the course of quantum computing and quantum algorithms as well as for self study It contains basic theoretical concepts and methods for solving basic types of problems and gives an overview of basic qubit operations entangled states quantum circuits implementing functions quantum Fourier transform phase estimation etc The book serves as a basis for the application of new information technologies in education and corporate technical training theoretical material and examples of practical problems as well as exercises with in most cases detailed solutions have relation to information technologies A large number of detailed examples serve to better develop professional competencies in computer science      Quantum Computing Algorithms Barry Burd,2023-09-22 Explore essential quantum computing algorithms and master concepts intuitively with minimal math expertise required Key Features Learn the fundamentals with an introduction to matrix arithmetic Write quantum computing programs in Qiskit IBM s publicly available quantum computing website Email your questions directly to the author no question is too elementary Purchase of the print or Kindle book includes a free PDF eBook Book DescriptionNavigate the quantum computing spectrum with this book bridging the gap between abstract math heavy texts and math avoidant beginner guides Unlike intermediate level books that often leave gaps in comprehension this all encompassing guide offers the missing links you need to truly understand the subject Balancing intuition and rigor this book empowers you to become a master of quantum algorithms No longer confined to canned examples you ll acquire the skills necessary to craft your own quantum code Quantum Computing Algorithms is organized into four sections to build your expertise progressively The first section lays the foundation with essential quantum concepts ensuring that you grasp qubits their representation and their transformations Moving to quantum algorithms the second section focuses on pivotal algorithms specifically quantum key distribution and teleportation The third section demonstrates the transformative power of algorithms that outpace classical computation and makes way for the fourth section helping you to expand your horizons by exploring alternative quantum computing models By the end of this book quantum algorithms will cease to be mystifying as you make this knowledge your asset and enter a new era of computation where you have the power to shape the code of reality What you will learn Define quantum circuits Harness superposition and entanglement to solve classical problems Gain insights into the implementation of quantum teleportation Explore the impact of quantum computing on cryptography Translate theoretical knowledge into practical skills by writing and executing code on real quantum hardware Expand your understanding of this domain by uncovering alternative quantum computing models Who this book is forThis book is for individuals familiar with algebra and computer programming eager to delve into modern physics concepts Whether you ve dabbled in introductory quantum computing material or are seeking deeper insights this quantum computing book is your gateway to in depth exploration

*Quantum Algorithms via Linear Algebra* Richard J. Lipton,Kenneth W. Regan,2014-12-05 Quantum computing explained

in terms of elementary linear algebra emphasizing computation and algorithms and requiring no background in physics This introduction to quantum algorithms is concise but comprehensive covering many key algorithms It is mathematically rigorous but requires minimal background and assumes no knowledge of quantum theory or quantum mechanics The book explains quantum computation in terms of elementary linear algebra it assumes the reader will have some familiarity with vectors matrices and their basic properties but offers a review of all the relevant material from linear algebra By emphasizing computation and algorithms rather than physics this primer makes quantum algorithms accessible to students and researchers in computer science without the complications of quantum mechanical notation physical concepts and philosophical issues After explaining the development of quantum operations and computations based on linear algebra the book presents the major quantum algorithms from seminal algorithms by Deutsch Jozsa and Simon through Shor's and Grover's algorithms to recent quantum walks It covers quantum gates computational complexity and some graph theory Mathematical proofs are generally short and straightforward quantum circuits and gates are used to illuminate linear algebra and the discussion of complexity is anchored in computational problems rather than machine models Quantum Algorithms via Linear Algebra is suitable for classroom use or as a reference for computer scientists and mathematicians

**Quantum Computers, Algorithms and Chaos** G. Casati, D.L. Shepelyansky, P. Zoller, 2006-12-19 During the last ten years Quantum Information Processing and Communication QIPC has established itself as one of the new hot topic fields in physics with the potential to revolutionize many areas of science and technology QIPC replaces the laws of classical physics applied to computation and communication with the more fundamental laws of quantum mechanics This becomes increasingly important due to technological progress going down to smaller and smaller scales where quantum effects start to be dominant In addition to its fundamental nature QIPC promises to advance computing power beyond the capabilities of any classical computer to guarantee secure communication and establish direct links to emerging quantum technologies such as for example quantum based sensors and clocks One of the outstanding feature of QIPC is its interdisciplinary character it brings together researchers from physics mathematics and computer science In particular within physics we have seen the emergence of a new QIPC community which ranges from theoretical to experimental physics and crosses boundaries of traditionally separated disciplines such as atomic physics quantum optics statistical mechanics and solid state physics all working on different and complementary aspects of QIPC This publication covers the following topics Introduction to quantum computing Quantum logic information and entanglement Quantum algorithms Error correcting codes for quantum computations Quantum measurements and control Quantum communication Quantum optics and cold atoms for quantum information Quantum computing with solid state devices Theory and experiments for superconducting qubits Interactions in many body systems quantum chaos disorder and random matrices Decoherence effects for quantum computing and Future prospects of quantum information processing

Natural Computing Algorithms Anthony Brabazon, Michael O'Neill, Seán

McGarraghy,2015-10-08 The field of natural computing has been the focus of a substantial research effort in recent decades One particular strand of this research concerns the development of computational algorithms using metaphorical inspiration from systems and phenomena that occur in the natural world These naturally inspired computing algorithms have proven to be successful problem solvers across domains as diverse as management science bioinformatics finance marketing engineering architecture and design This book is a comprehensive introduction to natural computing algorithms suitable for academic and industrial researchers and for undergraduate and graduate courses on natural computing in computer science engineering and management science

*Quantum Computer Science* Marco Lanzagorta,Jeffrey Uhlmann,2009-01-08 In this text we present a technical overview of the emerging field of quantum computation along with new research results by the authors What distinguishes our presentation from that of others is our focus on the relationship between quantum computation and computer science Specifically our emphasis is on the computational model of quantum computing rather than on the engineering issues associated with its physical implementation We adopt this approach for the same reason that a book on computer programming doesn't cover the theory and physical realization of semiconductors Another distinguishing feature of this text is our detailed discussion of the circuit complexity of quantum algorithms To the extent possible we have presented the material in a form that is accessible to the computer scientist but in many cases we retain the conventional physics notation so that the reader will also be able to consult the relevant quantum computing literature Although we expect the reader to have a solid understanding of linear algebra we do not assume a background in physics This text is based on lectures given as short courses and invited presentations around the world and it has been used as the primary text for a graduate course at George Mason University In all these cases our challenge has been the same how to present to a general audience a concise introduction to the algorithmic structure and applications of quantum computing on an extremely short period of time The feedback from these courses and presentations has greatly aided in making our exposition of challenging concepts more accessible to a general audience

Table of Contents Introduction The Algorithmic Structure of Quantum Computing Advantages and Limitations of Quantum Computing Amplitude Amplification Case Study Computational Geometry The Quantum Fourier Transform Case Study The Hidden Subgroup Circuit Complexity Analysis of Quantum Algorithms Conclusions Bibliography

**Mathematics of Quantum Computing** Wolfgang Scherer,2019-11-13 This textbook presents the elementary aspects of quantum computing in a mathematical form It is intended as core or supplementary reading for physicists mathematicians and computer scientists taking a first course on quantum computing It starts by introducing the basic mathematics required for quantum mechanics and then goes on to present in detail the notions of quantum mechanics entanglement quantum gates and quantum algorithms of which Shor's factorisation and Grover's search algorithm are discussed extensively In addition the algorithms for the Abelian Hidden Subgroup and Discrete Logarithm problems are presented and the latter is used to show how the Bitcoin digital signature may be compromised It

also addresses the problem of error correction as well as giving a detailed exposition of adiabatic quantum computing The book contains around 140 exercises for the student covering all of the topics treated together with an appendix of solutions

*Adaptive and Natural Computing Algorithms* Bartłomiej Beliczynski, Andrzej Dzieliński, Marcin Iwanowski, Bernadete Ribeiro, 2007-07-03 This two volume set constitutes the refereed proceedings of the 8th International Conference on Adaptive and Natural Computing Algorithms ICANNGA 2007 held in Warsaw Poland in April 2007 Coverage in the first volume includes evolutionary computation genetic algorithms and particle swarm optimization The second volume covers neural networks support vector machines biomedical signal and image processing biometrics computer vision

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